

WHAT IS CLAIMED IS:

1. A thin-film magnetic head comprising:
 - an inductive write head element including an upper core layer with a front end section magnetically coupling with an upper magnetic pole, a lower core layer with a front end section magnetically coupling with a lower magnetic pole, a coil conductor formed to pass between said upper core layer and said lower core layer, and an coil insulation layer for sandwiching said coil conductor; and
 - at least one thermal diffusion layer with a good thermal conductivity formed on said coil insulation layer at an outside region of said upper core layer.
2. The thin-film magnetic head as claimed in claim 1, wherein said at least one thermal diffusion layer is formed at a rear outside region of said upper core layer.
3. The thin-film magnetic head as claimed in claim 1, wherein said at least one thermal diffusion layer is formed at a lateral outside region of said upper core layer.
4. The thin-film magnetic head as claimed in claim 1, wherein only a thin coating film is formed on said at least one thermal diffusion layer.

5. The thin-film magnetic head as claimed in claim 4, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

6. The thin-film magnetic head as claimed in claim 1, wherein said at least one thermal diffusion layer is made of a material with a thermal conductivity higher than that of Al_2O_3 .

7. The thin-film magnetic head as claimed in claim 1, wherein said at least one thermal diffusion layer is made of a material with a thermal expansion coefficient lower than that of Al_2O_3 .

8. The thin-film magnetic head as claimed in claim 1, wherein said at least one thermal diffusion layer is made of a material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo.

9. A thin-film magnetic head comprising:
an inductive write head element including an upper core layer with a front end section magnetically coupling with an upper magnetic pole, a lower core layer with a front end

section magnetically coupling with a lower magnetic pole, a coil conductor formed to pass between said upper core layer and said lower core layer, and an coil insulation layer for sandwiching said coil conductor; and

at least one thermal diffusion layer with a good thermal conductivity formed at an outside region of said upper core layer, said at least one thermal diffusion layer being in contact with a part of said coil conductor or constituting a part of said coil conductor.

10. The thin-film magnetic head as claimed in claim 9, wherein only a thin coating film is formed on said at least one thermal diffusion layer.

11. The thin-film magnetic head as claimed in claim 10, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

12. The thin-film magnetic head as claimed in claim 9, wherein said at least one thermal diffusion layer is made of a material with a thermal conductivity higher than that of Al_2O_3 .

13. The thin-film magnetic head as claimed in claim 9, wherein said at least one thermal diffusion layer is made of a

material with a thermal expansion coefficient lower than that of Al_2O_3 .

14. The thin-film magnetic head as claimed in claim 9, wherein said at least one thermal diffusion layer is made of a material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo.

15. A manufacturing method of a thin-film magnetic head comprising the steps of:

forming a lower core layer with a front end section magnetically coupling with a lower magnetic pole;

forming a first coil insulation layer at least on said lower core layer;

forming a coil conductor on said first coil insulation layer, having a pattern to pass on said lower core layer;

forming a second coil insulation layer on said coil conductor;

forming an upper core layer with a front end section magnetically coupling with an upper magnetic pole, on said second coil insulation layer; and

forming at least one thermal diffusion layer with a good thermal conductivity on said second coil insulation layer

at an outside region of said upper core layer.

16. The manufacturing method as claimed in claim 15, wherein said method further comprises a step of forming bumps on connection terminals to be connected with said coil conductor, and wherein said at least one thermal diffusion layer is formed in said step of forming the bumps.

17. The manufacturing method as claimed in claim 15, wherein said method further comprises a step of forming under films for bumps formed on connection terminals to be connected with said coil conductor, and wherein said at least one thermal diffusion layer is formed in said step of forming the under films.

18. The manufacturing method as claimed in claim 15, wherein said at least one thermal diffusion layer is formed at a rear outside region of said upper core layer.

19. The manufacturing method as claimed in claim 15, wherein said at least one thermal diffusion layer is formed at a lateral outside region of said upper core layer.

20. The manufacturing method as claimed in claim 15, wherein said method further comprises a step of forming only a

thin coating film on said at least one thermal diffusion layer.

21. The manufacturing method as claimed in claim 20, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

22. The manufacturing method as claimed in claim 15, wherein said at least one thermal diffusion layer is made of a material with a thermal conductivity higher than that of Al_2O_3 .

23. The manufacturing method as claimed in claim 15, wherein said at least one thermal diffusion layer is made of a material with a thermal expansion coefficient lower than that of Al_2O_3 .

24. The manufacturing method as claimed in claim 15, wherein said at least one thermal diffusion layer is made of a material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo.

25. A manufacturing method of a thin-film magnetic head comprising the steps of:

forming a lower core layer with a front end section magnetically coupling with a lower magnetic pole;

forming a first coil insulation layer at least on said lower core layer;

forming a coil conductor on said first coil insulation layer, having a pattern to pass on said lower core layer;

forming a second coil insulation layer on said coil conductor;

forming a coil conductor on said second coil insulation layer, having a pattern to pass on said lower core layer;

forming a third coil insulation layer on said coil conductor;

forming an upper core layer with a front end section magnetically coupling with an upper magnetic pole, on said third coil insulation layer; and

forming at least one thermal diffusion layer with a good thermal conductivity on said third coil insulation layer at an outside region of said upper core layer.

26. The manufacturing method as claimed in claim 25, wherein said method further comprises a step of forming bumps on connection terminals to be connected with said coil conductor, and wherein said at least one thermal diffusion layer is formed in said step of forming the bumps.

27. The manufacturing method as claimed in claim 25, wherein said method further comprises a step of forming under films for bumps formed on connection terminals to be connected with said coil conductor, and wherein said at least one thermal diffusion layer is formed in said step of forming the under films.

28. The manufacturing method as claimed in claim 25, wherein said at least one thermal diffusion layer is formed at a rear outside region of said upper core layer.

29. The manufacturing method as claimed in claim 25, wherein said at least one thermal diffusion layer is formed at a lateral outside region of said upper core layer.

30. The manufacturing method as claimed in claim 25, wherein said method further comprises a step of forming only a thin coating film on said at least one thermal diffusion layer.

31. The manufacturing method as claimed in claim 30, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

32. The manufacturing method as claimed in claim 25,

wherein said at least one thermal diffusion layer is made of a material with a thermal conductivity higher than that of Al_2O_3 .

33. The manufacturing method as claimed in claim 25, wherein said at least one thermal diffusion layer is made of a material with a thermal expansion coefficient lower than that of Al_2O_3 .

34. The manufacturing method as claimed in claim 25, wherein said at least one thermal diffusion layer is made of a material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo.

35. A manufacturing method of a thin-film magnetic head comprising the steps of:

forming a lower core layer with a front end section magnetically coupling with a lower magnetic pole;

forming a first coil insulation layer at least on said lower core layer;

forming a coil conductor on said first coil insulation layer, having a pattern to pass on said lower core layer;

forming a second coil insulation layer on said coil conductor; and

forming an upper core layer with a front end section magnetically coupling with an upper magnetic pole, on said second coil insulation layer,

said method further comprising a step of forming at least one thermal diffusion layer with a good thermal conductivity at an outside region of said upper core layer, said at least one thermal diffusion layer being in contact with a part of said coil conductor or constituting a part of said coil conductor.

36. The manufacturing method as claimed in claim 35, wherein said at least one thermal diffusion layer is formed in said step of forming the coil conductor.

37. The manufacturing method as claimed in claim 35, wherein said method further comprises a step of forming only a thin coating film on said at least one thermal diffusion layer.

38. The manufacturing method as claimed in claim 37, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

39. The manufacturing method as claimed in claim 35, wherein said at least one thermal diffusion layer is made of a

material with a thermal conductivity higher than that of Al_2O_3 .

40. The manufacturing method as claimed in claim 35, wherein said at least one thermal diffusion layer is made of a material with a thermal expansion coefficient lower than that of Al_2O_3 .

41. The manufacturing method as claimed in claim 35, wherein said at least one thermal diffusion layer is made of a material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt, Pd, Mg and Mo.

42. A manufacturing method of a thin-film magnetic head comprising the steps of:

forming a lower core layer with a front end section magnetically coupling with a lower magnetic pole;

forming a first coil insulation layer at least on said lower core layer;

forming a coil conductor on said first coil insulation layer, having a pattern to pass on said lower core layer;

forming a second coil insulation layer on said coil conductor;

forming a coil conductor on said second coil insulation

layer, having a pattern to pass on said lower core layer;

forming a third coil insulation layer on said coil conductor; and

forming an upper core layer with a front end section magnetically coupling with an upper magnetic pole, on said third coil insulation layer,

said method further comprising a step of forming at least one thermal diffusion layer with a good thermal conductivity, said at least one thermal diffusion layer being in contact with a part of said coil conductor or constituting a part of said coil conductor.

43. The manufacturing method as claimed in claim 42, wherein said at least one thermal diffusion layer is formed in said step of forming the coil conductor.

44. The manufacturing method as claimed in claim 42, wherein said method further comprises a step of forming only a thin coating film on said at least one thermal diffusion layer.

45. The manufacturing method as claimed in claim 44, wherein said coating film is made of a material selected from Ti, Cr, Ta, Ni, Fe, Co, Au, Pt, Rh and Ru, or an alloy containing at least Ti, Cr, Ta, Ni, Fe or Co.

46. The manufacturing method as claimed in claim 42,
wherein said at least one thermal diffusion layer is made of a
material with a thermal conductivity higher than that of Al_2O_3 .

47. The manufacturing method as claimed in claim 42,
wherein said at least one thermal diffusion layer is made of a
material with a thermal expansion coefficient lower than that
of Al_2O_3 .

48. The manufacturing method as claimed in claim 42,
wherein said at least one thermal diffusion layer is made of a
material selected from Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta,
Fe, Pb, Ni, Pt, Pd, Mg and Mo, or an alloy containing at least
one of Au, Ag, Si, Zn, Al, Ir, Cd, Sb, W, Ta, Fe, Pb, Ni, Pt,
Pd, Mg and Mo.